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FACE RECOGNITION ACROSS ILLUMINATION, POSE AND OCCLUSION USING FRILPO ALGORITHM

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ABSTRACT — In recent years, face recognition is a significant research field in pattern recognition. While there has been a large amount of research on face recognition under pose and illumination changes, problem caused by occlusions. Face recognition with illumination, pose and occlusion will deteriorate the performance significantly. Such recognition tasks are very challenging in unconstrained environment. In this project work, an efficient approach has been developed, which consists of, five steps to recognize the face in an effective manner. Initially it detects the face with occlusion using haar cascade classifier and then separates the non-occluded face regions using Support Vector Machine classifier. Also it is essential to normalize and estimate the Frontal face from different pose of the obtained non-occluded part of face region for reducing the illumination effect and the next step is to extract the feature from normalized image using Multi-scale spatial weber local descriptor. Finally, the extracted feature of probe image is compared with the extracted feature of trained database images. Experimental results on comparing two extracted features of images will confirm that the proposed method achieves better performance than existing face recognition methods. Moreover, it can also estimate the area of image which belongs to the face or non-face with high accuracy, on the heavily occlude images.

Keywords— Face detection; SVM; Normalization; MSWLD; Face recognition

I. INTRODUCTION

Image processing is to perform operations on a given image, in order to compress an image and get an enhanced image other possibility to extract some useful information from it. Image processing is a type of signal processing in which consists of input is an image and output is an image or characteristics/features associated with that image. Currently, image processing is rapidly growing technologies. It creates important research area within computer science disciplines and engineering. An image is digitized and to convert it to form which can be stored in computer's memory. This digitization of image procedure can be done by scanner, or by video camera connected to frame grabber board in computer. Once image has been digitized, it can be utilized by many image processing operations. Image processing operations can be divided into three major categories: Image Enhancement, Image Compression, Measurement Extraction and Image Restoration. Image compression is well known to most people. It involves reducing the memory required to store single digital image. Image defects were caused by the digitization process or by mistakes in the imaging set-up (for example, worst lighting) it can be corrected by using Image Enhancement techniques. Once an image is in best condition, Measurement Extraction operations will be used to obtain valuable information from image. Some examples for Image Enhancement and Measurement Extraction are explained. Those examples show all operate on 256 grey-scale images. This explain that each pixel in an image is stored as a number range between 0 to 255, where 0 indicates a black pixel, 255 indicates a white pixel and values in-between indicates shades of grey. Those operations can be extended to work on color images. In color image contain RGB mode. Face recognition is a process that humans do routinely and effortlessly in everyday lives. Face recognition is significant research field in pattern recognition. Wide availability of embedded computing systems and low-cost and powerful desktop has created an enormous interest on automatic processing of digital images in a wide range of applications, including, human-computer interaction, surveillance, multimedia management, and biometric authentication. Research and development (R&D) in automatic face recognition follows certainly. Face recognition has numerous advantages over other biometric system such as iris besides being nonintrusive and natural and fingerprint, the most important advantage of face is that can able to captured at a distance and in a secret manner.

II. RELATED WORK

RPP estimation contain two models, namely the regression forest RF and Fern, both of them don't need to be retrained. We only take the second model consuming information obtained from the first model to make it more robust to heavy occlusions. Regression forests method is used to estimate the RPP (Region Predictive Power) of local regions. Regional Predictive Power estimation for localize landmarks [6]. Divide the input image into small cells. And then combine four cells into one block and one block is constituted by a cell of 2*2.Selection of direction channel and acquisition of the histogram. Process of normalization and create HOG features [8]. Haar feature classifier use rectangle integral to determine the value of a feature. Haar feature classifier multiplies the weight of each rectangle integral by its area and results are added together. A stage comparator group all Haar

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feature classifier results in a stage and compares this addition with a stage threshold [5]. WLD is powerful and robust local descriptor. WLD have ability to capture intensity variation in face image by its differential excitations and gradient orientation. It enhances its discriminative power using non-linear quantization rule. Multi-scale sub- images are employed to improve robustness to variations in pose and facial expressions. Decision fusion of matching reduces the negative influence of poor quality in presence of variations in illumination and partial occlusion [10].

III. EXISTING SYSTEM

Existing methods for face recognition with blur are based on the convolution model and cannot use non- uniform blurring images of tilted and shaken of cameras. In existing methodology [1] of face recognition with space varying motion blur with arbitrarily shaped kernels. By making the blurred face as a convex combination of geometrically converted instances of focused face of gallery and show all images obtained by non-uniformly blurring a given image from a convex set. Initially, propose a non-uniform blur-robust algorithm by use of the assumption of a sparse camera trajectory in the camera motion space. Then algorithm is extended to handle illumination variations by non-uniform blurring image and changing the illumination image forms a bi-convex set.

Finally, proposed algorithm for extension to variation in pose. In existing methodology to perform face recognition under the combination of non-uniform blurs, illumination, and pose. All images obtained by non-uniformly blurring a given image using the TSF model. A non-uniform motion blur-robust face recognition algorithm NU-MOB was proposed. Set of all images obtained from a given image by non-uniform blurring image and changes in illumination image forms a bi-convex set, and used these to develop the non -uniform motion blur and illumination-robust algorithm MOBIL. Algorithm then extended the MOBIL algorithm to use even non-frontal faces by converting the gallery to a new pose. This extension of this algorithm called MOBILAP. Extensive experiments were given on synthetic face data as well as real face data. The limitation of existing approach is significant occlusions and large changes in facial expressions cannot be handled.

IV. PROPOSED SYSTEM

Face recognition is a significant research field in pattern recognition. Face recognition facing many problems such as Illumination, Pose, occlusion, facial expression, low resolution, non-uniform motion blur. Face detection is an important unavoidable pre -processing step in face recognition. Consider a test image with different illumination, pose and occlusion. Face detection with occlusion is challenging in unconstrained environment. To improve occlusion detection rate in face by using SVM classifier. Face and face parts detection using viola and jones algorithm. Face detection can be done by viola-jones method it contain haar cascade classifier. Face alignment consists of align of face by normalization. It reduces the effect of illumination by using histogram equalization. To obtain the average face depth map of train gallery images is used for detect test image under different pose. Train image convert to .bmp file format for a non-compressive bit-mapped format in which individual pixel values can easily be extracted. Probe image convert to sub blocks extract histogram from each block region. Chip square distance is used to measure the similarity of two histograms. The matching results of feature vectors of the test face image and train gallery images are calculated by Gabor filter, Euclidean distance and nearest neighborhood method based on Chi- square distance.

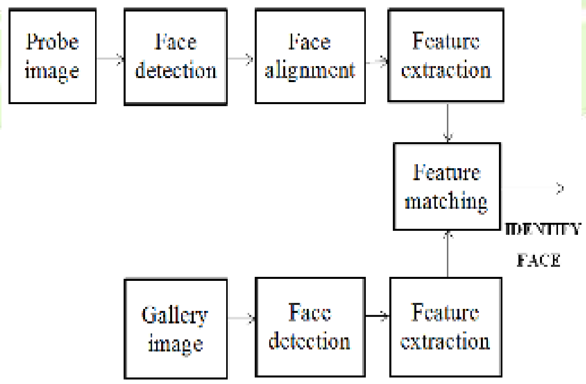

Fig.1. Block diagram of proposed system

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ALGORITHM

FRILPO ALGORITHM: FACE RECOGNITION ACROSS ILLUMINATION, POSE AND OCCLUSION

INPUT: Occlude and differently illuminated probe image under different pose, and set of gallery images $f_m, m = 1,2, \ldots, M$

OUTPUT: Identity of probe image

- Detect a non-occlude part of the probe image using SVM classifier.
- Obtain an estimate of frontal face of test image under different pose based on average face depth map for above non-occlude part of image.
- For synthesized test image reduce illumination based on normalization.
- Feature extracted from synthesized test image.
- For each gallery image f_m obtain the feature vector using WLD.
- Compare the WLD feature of probe image g with those of trained gallery image and find the closest match.

A. FACE DETECTION TECHNIQUES

Face detection is mandatory pre-processing step in face recognition and also difficult to detect face in presence of occlusion**.** Viola and Jones's face detection algorithm is used to detect a face and it based on Haar-like features. A set of haar-like features can be used to encode the contrast displayed by a human face and it also encodes their special relationships. In Viola and Jones's method, a cascade of classifiers (i.e. a group of weak classifiers instead of one individual strong classifier) working with Haar-like features is trained with many sample of face and non-face examples, they are scaled to same size.

The motivation behind the cascade of boosted classifier is simple classifiers at starting stage can filter out maximum negative examples efficiently, and stronger classifiers deal with instances that look like faces are only necessary at later stage. After the classifier is trained, it can be applied to an input image. To search for face, one can move the search window across the image and check every location using the classifier.

1. HAAR CASCADE CLASSIFIER

Haar cascade classifier, an image is classified as human faces if it passes all the conditions $\{f_1, f_2, \ldots \ldots \ldots . f_n\}$. If at any stage of one or more conditions is false then the image does not contain the human face.

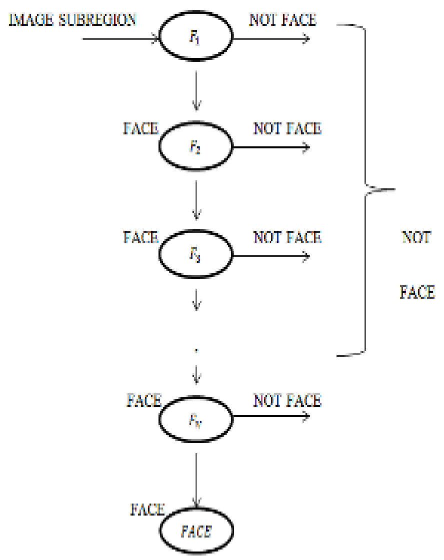

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Fig.2. Haar Cascade Classifier

TABLE I ACCURACY OF FACE DETECTION ON REAL DATASET

DETECTION	
ACCURACY (%)	TECHNIQUES
96.70	Haar cascade
89.30	LBP
90.88	HOG

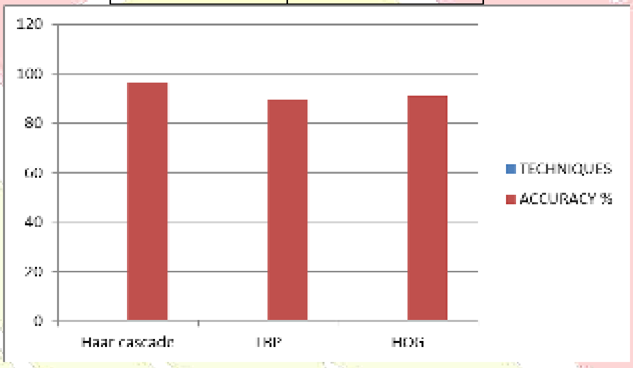

Fig.3. Accuracy of Face Detection Techniques

B. SVM CLASSIFIER

SVM (Support Vector Machine) helps to classify the data by set of support vector. It also provides generic mechanism to robust the surface of the hyper plane to the data through. It has low expected probability of generalization errors.

SVM generate a hyper plane between two datasets for classification for determine which is belongs to face or not. An SVM (Support Vector Machine) classifies the data by detecting the best hyper plane that splits all data points of one class from data points present in the other class. The best hyper plane for an SVM means the one with largest margin between the two classes. Meaning of margin is the maximal width of the slab parallel to the hyper plane that has no interior data points.

Hyper plane $(XT.w - b) > 0$ label as +1

X-Input data $(XT.w - b) < 0$ label as -1

C. FACE ALIGNMENT

Face alignment part consists of normalization and classification of non-occlude face image. The face images may have been captured under different lighting conditions and with different camera parameters in these situations normalization improves the robustness of the system.

D. NORMALIZATION

The basis of normalization is a correlated change of brightness level in a selected region of an image. It provides a working 'norm' for a particular location within the slice. One factor informs the choice of a grayscale reference norm is the first choice for adjusting brightness values upwards rather than downward in order to keep all data of image accessible. Any grayscale values minimized to zero lose all information.

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E. WLD

In features extraction stage, WLD indicate an image as a histogram of gradient orientations and differential excitations. WLD descriptor is based on Weber's Law. According to weber's law the ratio of the increment threshold to the background intensity is constant. Weber's law is defined as ratio of ΔI represents the increment threshold and I represent the initial stimulus intensity and k indicate the proportion on the left hand side of the equation will remains constant despite variations in I term. The fraction ΔI/I is called as the Weber fraction. Weber's Law, can be stated as:

$$\frac{\Delta I}{I}=k$$

Then Gabor filter will be used to extract facial features from face regions to distinguish the illumination changes. It will be useful to characterize and discriminate the texture of an image. The computation of WLD descriptor involves three components: calculating gradient orientations, differential excitations and constructing the histogram.

DIFFERENTIAL EXCITATION:

For measuring differential excitation $\mathcal{E}$ (x_c) of each pixel *x,* first intensity differences of x_c with its neighbour's pixel x_i, i = 0, 1, 2… *p-1* are measured as

$$\Delta I = I_i - I_c \qquad \text{(a)}$$

After the ratio of total intensity difference between x_c and its neighbour's x_i pixel to intensity of x_c is calculated as

$$f_{ratio} = \sum_{i=0}^{p-1} \frac{\Delta I_i}{I_c} \qquad \text{(b)}$$

Arctangent function is consider as a filter on Equation (b). To enhance the robustness of WLD against noise that gives

$$\in (X_c) = arctan \sum_{i=0}^{p-1} \varepsilon \left(\frac{\Delta I_i}{I_c}\right) \qquad \text{(c)}$$

The differential excitation $\mathcal{E}(x_c)$ values may be positive or negative. The positive value represents that current pixel is darker than the surroundings and negative value represents that the current pixel is lighter than its surroundings.

GRADIENT ORIENTATION:

Second main component of WLD is gradient orientation. For each pixel the gradient orientation is measured as

$$\theta(X_c) = arctan\left[\frac{I_{73}}{I_{51}}\right] \qquad \text{(d)}$$

Where $I_{73} = I_7 - I_3$ is the intensity difference of 7 and 3 pixel is present in the left and right of the current pixel x_c and $I_{51} = I_5 - I_1$ is the intensity difference of 5 and 1 pixel is present in top and bottom of the current pixel. Reminder that $[-\pi/2, \pi/2]$.

The gradient orientations values are quantized into *T* dominant orientations as follows

$\emptyset_{t=\frac{2t}{T}\pi}$ in these place value of $t = mod\left(\left|\frac{\theta}{\frac{2\pi}{T}} + \frac{1}{2}\right|, T\right)$ (e)

Where $\theta' \epsilon [0, 2\pi]$ and is described in terms of gradient orientation calculated by Eq.(d) as follows

$$\theta' = arctan2(I_{73}, I_{51}) + \pi$$

In case T=8, the dominant orientations are $\emptyset_t = \frac{t\pi}{4}$ t=0, 1……….T-1; all orientations located in the interval $\left[\emptyset_t - \left(\frac{t\pi}{4}\right), \emptyset_t + \left(\frac{t\pi}{4}\right)\right]$ are quantized as $\emptyset_t$

1. BASIC WLD DESCRIPTOR

After calculating differential excitation, gradient and dominant orientation, WLD descriptor is constructed. Corresponding to each dominant orientation: *t* = 0, 1, 2, …, *T*-1 differential excitations are planned as a histogram H_t. Then each

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histogram H_t: t = 0, 1, 2…, T-1 is evenly divided into S sub-histograms H_s, t: s = 0, 1, 2, …, S-1, each with M bins. These obtained histograms form a histogram matrix, here consider each column corresponds to a dominant direction and individual row of this matrix is concatenated as each histogram row of this matrix is concatenated as each histogram H_s = {H_s , t: t = 0, 1, 2…, T-1}. Subsequently, histograms H_s: s = 0, 1, 2… M-1 are convert into a histogram for H = { H_s: s = 0, 1,2, …, S-1}. This histogram is considered as WLD descriptor. This WLD descriptor involves three parameters: T indicates the number of dominant orientations, S indicates the number of segments of each histogram corresponding to each dominant orientation and M indicates the number of bins in a segment.

2. SPATIAL WLD DESCRIPTOR

The basic WLD descriptor indicates an image as a histogram of differential excitations planned according to dominant gradient orientations. In basic WLD descriptor histogram differential excitations are collected according to their corresponding values and gradient dominant orientations unrelated to their spatial location. Spatial location information is also an significant factor for better description. Take an example, two different regions of face image with same differential excitations and gradient orientations it will contribute to same bins in histogram, and it will not be discriminated by Weber Local Descriptor.

To improve the discriminatory power of WLD descriptor, initiate spatial information into WLD descriptor. Initially divide an image into a number of blocks and then compute WLD histogram for each block and combine them to form a Spatial Weber Local Descriptor (SWLD). SWLD involves four parameters: T, S, M and the number blocks for an image. This method performs better because it captures the local spatial information efficiently and this information is significant for recognition purpose. But this SWLD approach introduces another parameter is size of blocks. The optimal value of size of blocks parameter can direct to better recognition results.

3. MEMETIC OPTIMISED MCWLD

Multi-scale Circular WLD (MCWLD) is advanced image descriptors when compared with above methods. Here WLD is improved for matching sketches with digitized face images by calculating multi-scale descriptor (MCWLD) in a circular manner. Structural related information with minute information present in local facial regions would be encoded using Multi-scale Circular WLD (MCWLD). A proposed memetic optimization is to assign the optimal weights to each local facial region to improve the identification performance. Memetic optimization is an automated algorithm that gets discriminating information from local facial regions of both digital face images and sketches. Memetic optimization algorithm yields better verification performance compared to other existing face recognition algorithms. There are three different types of sketches as viewed sketches drawn by a sketch artist(look digital image), Semi-forensic sketches drawn by a sketch artist (based on his recollection) Forensic sketches drawn (based on the description of an eyewitness). MCWLD consists of two components: differential excitation, gradient orientation.

MCWLD representation of the given face image is constructed by dividing the face image and calculating a descriptor for each region. MCWLD descriptor is calculated for different parameters N and C values, where N is the number of neighbouring pixels separated on a circle of radius C centre at the current pixel. Multi-scale analysis is performed by varying the radius C and number of neighbors N.

4. MULTI-SCALE SPATIAL WLD DESCRIPTOR

Spatial Weber Local Descriptor describes both gradient orientation and spatial information at fixed granularity. For improved representation of an image, it is significant to capture local micro-patterns at varying scales (R, P). To achieve this improvement, initiate Multi-scale Spatial WLD descriptor in this case for each block of an image, a multi-scale WLD histogram at a particular scale (R, P) is calculated and then these histograms are combined. The final histogram is Multi-scale Spatial WLD descriptor (MSWLD) at scale (R, P).

Finally, indicate Multi-scale Spatial WLD operator by *SWLD* and *R, P* (*T*, *M*, *S, n*). MSWLD use for face recognition or feature extraction by tuning parameters T, M, S and number of blocks. All the tuning features in MSWLD descriptor are not useful in recognition some features are difficult, to get rid of difficult features initiate and employ Fisher score method for feature selection and also use minimum distance classifier with CS (chi square) distance measure.

TABLE II ACCURACY OF FACE DETECTION

ON REAL DATASET

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FACE RECOGNITION	
ACCURACY (%)	TECHNIQUES
71.15	PCA
77.90	LDA
82.94	LBP
91.40	SIFT
97.50	WLD
98	MSWLD

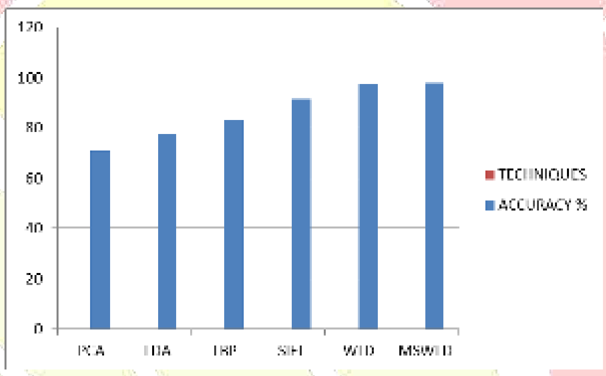

Fig.4. Accuracy of Face Recognition Techniques

TABLE III RECOGNITION RESULT FOR FRILPO ON REAL DATASET ALONG WITH COMPARISON

METHOD	RECOGNTION RATE (%)
Proposed	86.34
MOBILAP	76.18
IBBF	58.50

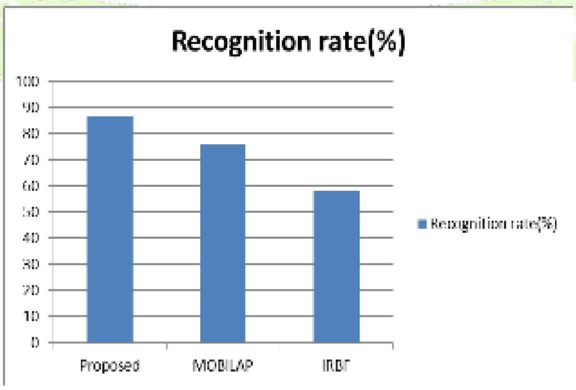

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Fig.5. Recognition Rate of Method

V. EXPERIMENTAL RESULTS

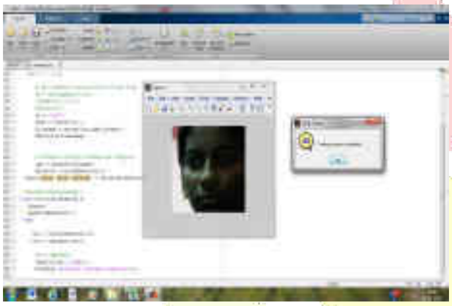

Fig.6. Train the images

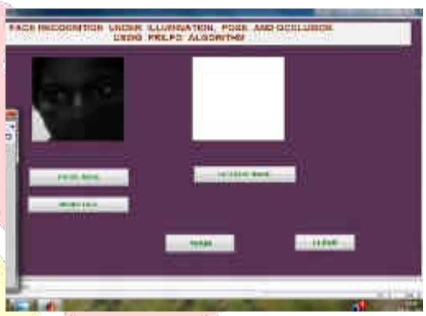

Fig.7. Test image

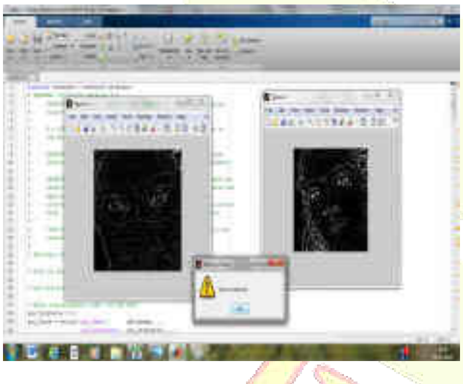

Fig.8. Feature Matching(not matched face)

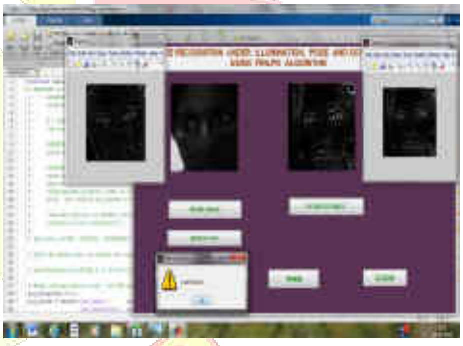

Fig.9. Feature Matching(mathced face)

VI. CONCLUSION

Face recognition with illumination, pose and occlusion will deteriorate the performance significantly. Such recognition tasks are very challenging in unconstrained environment. Hence, it is essential to develop an algorithm in order to improve the face recognition. Even though many algorithms have been developed to recognize the face under different pose and illumination changes but problem caused by in presence of occlusion. In proposed system, it improves the occlusion detection rate for better face recognition in presence of occlusion. Initially proposed the face recognition under illumination, pose and occlusion algorithm for recognize the face under different pose, illumination changes and occlusion. It is applied for real time still images.

VII. FUTURE ENHANCEMENT

Proposed system provides enough feature extraction for smaller database. Hence, it is essential to develop an approach to adopt the feature extraction method in order to withstand larger database in an effective manner. Also, it is considered to reduce the computational time while extracting the features in the real world security applications.

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